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POSSIBLE DESIGN OF BLENDED WING STEALTH VTOL BOMBER AIRCRAFT

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ABSTRACT

The VTOL aircrafts are also considered the next generation aircrafts which can land on any terrain. These aircrafts are considered to be the next generation which won't require a long runway to land and takeoff. Blended wing is the design in which wings are integrated into the fuselage which reduces the drag increasing the fuel efficiency of the aircraft. These two features can provide an aircraft which can also be used for military purposes in cross-border troop transport and bombing runs without getting detected in the enemy radar. This paper gives an idea of a conceptual design of such an aircraft. Few of the parameters of the aircraft based on the weight requirements for the desired mission (Bombing runs) is taken which is usually high as the aircraft should be able to carry enough bombs than the current bombers with greater fuel efficiency.

KEYWORDS-: VTOL Aircraft, Blended Wing, Military Bomber, Stealth Aircraft & Aircraft Design

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1 INTRODUCTION

Aircrafts have come a long way from the human first heavier than air flight in 1903 at Kittyhawk, USA by the Wright Brothers. This flight has taken us from WW1 wooden biplanes to WW2 metal and jet powered aircrafts. Now most of the aircrafts manufacturers make aircrafts out of advance materials which are lighter than aluminium and having the strength greater than that of steel like the Boeing 787 which was made more than 80% of plastic composite. S/VTOL aircraft combines the advantages of fixed-wing aircraft and rotary-wing aircraft. It can significantly improve the aircraft's the take-off and landing ability to reduce the requirements for the take-off and landing environment, the higher flight speed can improve manoeuvre ability as well. [1] Blended wing design is the new modification of the aircraft shape in which the wing is integrated into the fuselage which in turn reduces the drag and provides better efficiency. When combined with VTOL technology the aircraft developed would be the higher efficient aircraft with less runway requirement for landing and take-off. This paper reviews the conceptual design of such an aircraft for military purposes as a aircraft which can be used as a bomber as well as troop transport with very less radar signature will provide an upper hand during war and for cross border troop deployment and bombings.

This aircraft designed is based to make a stealth strategic bomber with VTOL capabilities. This aircraft can also be used as a troop transport essential for the rescue operations so that more number of people can be evacuated at a single time.

This paper is the study of a conceptual blended wing VTOL aircraft design. This design is made using hand calculation and the design is rendered in Solidworks and analysed at cruise and landing and take-off condition using ANSYS Fluent before prototyping a model to virtually check if the aircraft would really be able to fly and

the changes needed to be done based on the simulations.

The maximum take-off weight and the payload and crew weight is assumed with other parameters selected for the mission design in table 1. The cruising altitude is fixed at 20 km above the sea level with a 12,000 km range with cruise velocity of Mach 0.8 or 236.08 /s.

The fuel weight of the aircraft is calculated using the flight profile of the aircraft and from weight ratios of previous known data. The flight profile is given in Figure.1 which is selected as a basic take-off, loiter/bombing and landing. The aircraft is assumed to be capable of dropping bombs from cruising altitude.

The aircraft is in a conceptual phase and a few more simulation results have to be compared with the hand calculations done to predict how the aircraft will behave in the real environment due to which the aircraft is expected to undergo a lot of changes before the final parameters are fixed for a prototype.

2 MISSION PROFILE AND PREDETERMINED PARAMETERS

The aircraft is assumed to be able to carry 50 bombs of 230 kg and a crew of 2 each 100kg making the payload weight of 11,700 kg. The maximum takeoff weight ($W_{TOGuess}$) of the aircraft is taken to be 120,000 kg or 264554.715 lbs.

$$W_{total} = W_{TOGuess} + W_{payload} + W_{Crew}$$

$$W_{payload} + W_{Crew} = (50 * 230) + 200$$

$$W_{payloadl} + W_{Crew} = 11700\ kg$$

The other parameters selected are given in Table.1. These are conceptual design values.

Table 1

Parameter	Value
Range	12,000 km
Max Takeoff weight	120000 kg
Cruising Altitude	20 km
Cruise Velocity	Mach = 0.8 (236.08 m/s)
Maximum Velocity	Mach = 1.2
Length	50 m
Height	5 m
Aspect Ratio	3.5
Wing Span	140

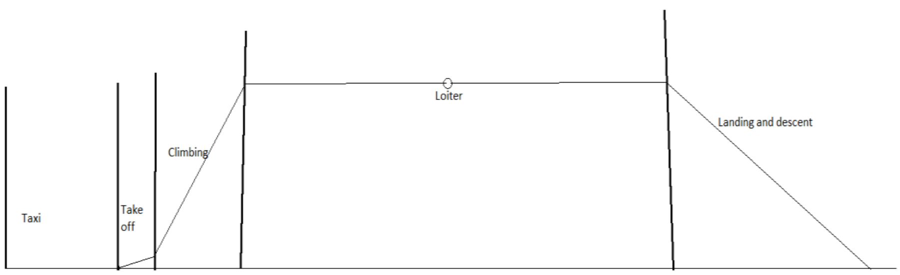

Figure 1: Aircraft Mission Profile.

2.1 Mathematical Equations and Calculation

The weight ratio given in table 2 and range are used to find the fuel weight required for the aircraft to complete its mission while table 3 gives the cruise and loiter parameter. These tables are the approximate values which were found out from historic experiments of different aircrafts. The aircraft weight ratio selected from is Military Bomber.

Table 2: Fuel Fraction for Several Mission Phases

Mission Phase /Airplane Type	Engine Start, Warm up	Taxi	Take-off	Climb	Descent	Landing taxi, Shutdown
Single Engine	0.995	0.998	0.998	0.995	0.995	0.995
Transport Jets	0.990	0.990	0.995	0.980	0.990	0.992
Fighters	0.990	0.990	0.990	0.96-0.90	0.990	0.995
Military patrol, Bomber, Transport	0.990	0.990	0.995	0.980	0.990	0.992
Supersonic Cruise	0.990	0.995	0.995	0.92-0.87	0.985	0.992

Table 3: Mission Cruise and Loiter Parameter

Mission phase	Cruise				Loiter			
Aircraft Type	L/D	C_j	C_p	η_p	L/D	C_j	C_p	η_p
Single Engine	8-10	NA	0.6-0.8	0.7	10-12	NA	0.5-0.7	0.6
Transport Jets	13-15	0.5-0.9	NA	NA	14-18	0.4-0.6	NA	NA
Fighters	4-7	0.6-1.4	0.5-0.7	0.82	6-9	0.6-0.8	0.5-0.7	0.77
Military patrol, Bimber, Transport	13-15	0.5-0.9	0.4-0.7	0.82	14-18	0.4-0.6	0.5-0.7	0.77
Supersonic Cruise	4-6	0.7-1.5	NA	NA	7-9	0.6-0.8	NA	NA

2.1 Weight Estimation

2.1.1 Engine Start & Warm Up

The following calculation gives the weight of the aircraft in the engine start and warm up phase by converting the give weight from kg to pound.

The assumed take-off weight was 264554.715 lbs.

$$\frac{W1}{W_{toguess}} = 0.990$$

- W1 = $W_{toguess}$* 0.990
- W1 = 264554.715 * 0.990
- W1 = 261909.16785lbs

2.1.2 Taxiing

The following calculation gives the weight of the aircraft in the taxiing phase,

$$\frac{W1}{W2} = 0.990$$

- W2 = W1 * 0.990
- W2 = 261909.16785 * 0.990

- W2 = 259290.0762lbs

2.1.3 Take-Off

The following calculation gives the weight of the aircraft in the take-off phase,

$$\frac{W3}{W2} = 0.995$$

- W3 = W2 * 0.995
- W3 = 261909.16785 * 0.995
- W3 = 257993.6258 lbs

2.1.4 Climb

The following calculation gives the weight of the aircraft in the take-off phase,

$$\frac{W4}{W3} = 0.980$$

- W4 = W3 * 0.980
- W4 = 257993.6258 * 0.980
- W4 = 252833.7533lbs

Now for range and loiter the few predefined values were taken from the Table 3.

2.1.5 Cruise

The Range of the jet aircraft is given by the following equation and W5 is calculated from the same,

$$R_{cr} = \left(\frac{V}{C_j}\right) * \left(\frac{L}{D}\right) * \ln\left(\frac{W4}{W5}\right)$$

The following values are taken from the table 3, R_{cr} = 6000 km or 3728.227 miles

V = 0.8 Mach (at 20,000m) or 528.09 miles per hour C_j = 0.5 lbs/hr

L/D=14

- 3728.227 = (528.09/0.5) *(14) *ln(W4/W5)
- ln(W4/W5) = 0.3529
- W5/W4 = 0.777
- W5 = 196451.8263 lbs

2.1.6 Loiter

The Loiter time of the jet aircraft is given by the following equation and W6 is calculated from the same,

$$E_{ltr} = \left(\frac{1}{C_j}\right) * \left(\frac{L}{D}\right) * \ln\left(\frac{W5}{W6}\right)$$

The following values are taken from the Table 3, E_{ltr} = 0.5 hour

C_j = 0.5 lbs/hour

L/D = 16

- 0.5 = (1/0.5) *16*ln(W5/W6)
- W6/W5 = 0.9845
- W6 = 193406.823 lbs

2.1.7 Returning Back

The following calculations are done for the returning mission of the bomber at same cruising altitude,

$\frac{W7}{W6} = 0.777$

W7 = 150277.1015 lbs

2.1.8 Descent

The following calculations are done for the descent phase of the aircraft

$W$8/W7 =0.990

- W8 = W7*0.990
- W8 = 148774.3305 lbs

2.1.9 Landing

The following calculations are done for the descent phase of the aircraft,

$W$9/W8 =0.992

- W9=W8*0.992
- W9 = 147584.1358 lbs

2.1.10 Calculation of M_{ff}

The $M_{ff}$is given by the following formula,

$$M_{ff} = \left(\frac{W9}{W8}\right) * \left(\frac{W8}{W7}\right) * \left(\frac{W7}{W6}\right) * \left(\frac{W6}{W5}\right) * \left(\frac{W5}{W4}\right) * \left(\frac{W4}{W3}\right) * \left(\frac{W3}{W2}\right) * \left(\frac{W2}{W1}\right) * \left(\frac{W1}{W_{toguess}}\right)$$

M_{ff}= 0.5578

2.1.11 Weight of Fuel

The weight of the fuel, W_f is calculated using the following formula, W_f= (W_{used} + W_{res})Where, W_{used} = (1-M_{ff})*W_{to}

- W_{res} = 5-10% of W_{used}
- W_{used}= 116986.095 lbs
- W_{res} = 5849.304749 lbs

- W_f = 122835.3997 lbs

2.1.12 WOE Tentative

The Woe tentative is calculated using the following formula, $Woe\ tentative\ =\ Wtoguess - Wf - Wpl$ $Where, Wtoguess\ =\ 264554.715$ lbs

- $Wf\ =\ 122835.3997\ lbs$
- $Wpl\ =\ 25353.16\ lbs$
- $Woe\ tentative\ =\ 264554.715\ -\ 122835.3997 - 25353.16$
- $Woe\ tentative\ =\ 116366.1553\ lbs$

2.1.13WE Tentative

The WE Tentative is calculated using the following formula,

- $WE\ Tentative\ =\ Woe\ tentative - Wtfo - \ Wcrew$
- $Where, Woe\ tentative\ =\ 163627.6485\ lbs$
- $Wtfo\ =\ 1750\ lbs\ (Reserved\ weight\ for\ avionics)$
- $Wcrew =\ 352.74\ lbs$
- $We\ tentative\ =\ 116366.1553\ - 1750 - 352.74$
- $We\ tentative\ =\ 114263.4153\ lbs$

2.1.14 WE Actual

The WE Actual is calculated using the following formula, WE Actual = $invlog10$ [(log10WTO - A)/B]

Where,

A = -0.2009

B = 1.1037

WE actual = 123026.87708 lbs

2.1.15 Error Percentage

The Error is given by the following formula.

$$Error\ \% = \left[\frac{We\ actual - We\ tenative}{We\ actual}\right] * 100$$

WE Actual = 123026.87708 lbs, WE Tentative = 114263.4153 lbs

$Error$% = 7.123%

2.2 Airfoil Parameters

The airfoil used is the NACA 63-212 airfoil which is a six series airfoil. The polar coordinates of the airfoil are taken using

the software X-Foil from 0degrees angle of attack to 19 degrees. The polar coordinate data is given in table 4.

Table 4: Airfoil Polar Coordinate for Cruise Condition (Using X-Foil)

Alpha	CL	CD	CM
0	0.0829	0.00429	-0.0403
1	0.2935	0.00512	-0.042
2	0.4085	0.00528	-0.0427
3	0.5219	0.00569	-0.0431
4	0.6281	0.0072	-0.043
5	0.7309	0.0092	-0.0425
6	0.8376	0.01033	-0.0421
7	0.942	0.0115	-0.0414
8	1.0384	0.01276	-0.0391
9	1.1353	0.01443	-0.0374
10	1.2292	0.01655	-0.036
11	1.3028	0.02002	-0.032
12	1.3652	0.02308	-0.0267
13	1.4057	0.02755	-0.0209
14	1.4412	0.03323	-0.0175
15	1.4308	0.04472	-0.0156
16	1.4203	0.05813	-0.0179
17	1.3874	0.0772	-0.0252
18	1.3345	0.10319	-0.0384
19	1.2365	0.14273	-0.0617

Table 5: Airfoil polar coordinate for Landing and Take-off Condition (Using X-Foil)

Alpha	CL	CD	CM
0	0.1775	0.00526	-0.0411
1	0.2931	0.00528	-0.0419
2	0.4079	0.00544	-0.0425
3	0.5213	0.00581	-0.043
4	0.6288	0.00707	-0.0428
5	0.7296	0.00935	-0.0422
6	0.835	0.01063	-0.0416
7	0.938	0.01188	-0.0406
8	1.0335	0.01308	-0.0381
9	1.1282	0.01519	-0.0364
10	1.2203	0.01742	-0.0347
11	1.297	0.02051	-0.0312
12	1.342	0.02491	-0.0242
13	1.3796	0.03004	-0.019
14	1.4096	0.03657	-0.0161
15	1.4242	0.0456	-0.0155
16	1.406	0.06003	-0.0181
17	1.3254	0.08848	-0.0295
18	1.2603	0.11752	-0.0461
19	1.156	0.16259	-0.0741

The following data gives us the maximum coefficient of lift (Cl) at 16 degrees of angle of attack of 1.4074.

2.1.16 Aircraft Surface Area

The following calculation is done to find the Surface area of wing:

$$Aspect\ Ratio = \frac{Wing\ Span^2}{Surface\ Area}$$

$$Surface\ Area\ =\ Wing\ Span^2/\ Aspect\ Ratio$$

$$\mathrm{S}\ =\ 5600\ \mathrm{m^{\wedge}2}$$

2.1.17 Stall Velocity of Aircraft

The following calculation is done to find the Vstall of the aircraft and the corresponding Cl and Cd values are taken from the table 4:

$$V_{stall} = \sqrt{(2W)/(\rho * S * Cl_{max})}$$

Where,

W = 1177200 N

ρ = 1.225 kg/m3 S = 5600 m2

Clmax = 1.4242

$\boldsymbol{Vstall}$ = 15.61598$\boldsymbol{m}/\boldsymbol{s}$

2.2 Lift and Drag

2.2.1 Lift During Takeoff

The following calculation is done to find the Lift during takeoff

$$L = (\rho * V_{takeoff}^2 * S * Cl)/2$$

Where,

$$Vtakeoff\ =\ 2\ *\ Vstall\ =\ 2\ *\ 15.61598\ =\ 31.23\ m/s$$

$$S = 5600\ m2$$

$$Cl\ =\ 1.4074$$

$$\rho\ =\ 1.225\ kg/m3$$

$$L\ =\ \mathbf{423.792}\ KN$$

2.2.2 Lift During Landing

The following calculations are done to find lift generated by wings during landing:

$$L = (\rho * V_{Landing}^2 * S * Cl)/2$$

Where,

$$VLanding\ =\ 1.2\ *\ Vstall\ =\ 1.2\ *\ 15.61598\ =\ 18.736\ m/s$$

$$S = 5600\ m2$$

$$Cl\ =\ 1.4074$$

$\rho \ = \ 1.225 \ kg/m3$

$L \ = \mathbf{497.366 \ KN}$

2.2.3 Lift During Cruise

The following calculations are done to find lift generated by wings during landing:

$L = (\rho * V_{Cruise}^{2} * S * Cl)/2$

Where,

$Vcruise$ = 236.08 m/s

S=5600 m2

Cl = 0.0829

ρ = 0.08891 kg/m3

***L* =1150.22 KN**

2.2.4 Drag During Cruise

The following calculations are done to find lift generated by wings during landing:

$D = (\rho * V_{cruise}^{2} * S * Cd)/2$

Where, D = Drag

V = Cruise velocity = 236.08 m/s,

S = surface area = 5600 m2

Cd = Drag coefficient = 0.00429

D = **59.65*KN***

2.2.5 Drag During Takeoff

The following calculation is done to find the drag generated during the Take-off :

$D = (\rho * V_{takeoff}^{2} * S * Cd)/2$

Where,

Cd = 0.06

D = **31.76*KN***

2.2.6 Drag During Landing

The following calculation is done to find the drag generated during landing:

$D = (\rho * V_{landing}^{2} * S * Cd)/2$

Where,

Cd = 0.06

D **= 37.273*KN***

2.3 Performance Calculation

Based on the above calculation the engine was selected to overcome the drag of the Aircraft. The engine selected is Pratt and Whitney F-135 engine and a total of four engines to be mounted on the aircraft in a buried wing configuration. The overall thrust produces is 480KN (dry) and 720KN(Wet).

The calculations below are made taking the engine thrust in consideration. This engine would also provide shaft power to the rotor blades on the wing.

2.3.1 Rate of Climb

The Rate of Climb is given by the formula,

$$\left(\frac{R}{C}\right)_{max} = \frac{[(T*Vstall)-(D*Vstall)]}{Wto*9.8}$$

Where, $Vstall = 15.62\ m/s$

$WTo = 120000\ kg$

$D = 63520\ N$

$T = 728000\ N$

$$\left(\frac{\boldsymbol{R}}{\boldsymbol{C}}\right)_{\boldsymbol{max}} = \mathbf{8.7\ m/s}$$

2.3.4 Hovering

Lift generated by fans is equal to Weight which is the Thrust developed by Fans

Thrust = Lift = weight

W = Take-off Weight = 120000 kg

Thrust Required by fans = 120000*9.81 N

TFans = 1177200 N

The Thrust required by One fan = T/2

T = 1177200/2

- **T = 588.6 KN**

2.3.5 Velocity Generated by One Fan

$$T = \left(\frac{\pi}{2}\right) * D^2 * \upsilon * \Delta\upsilon * \rho$$

Where, T = thrust developed by fan = 588.6 KN

D = diameter of the Fan = 13.368 m

ρ = Density = 1.225

v = velocity of air while entering fan = (1/2) *Δv

Δv = Velocity generated by fan

$\Delta \boldsymbol{v}$ = 82.745 m/s

2.3.6 Power Required by Single Fan

T = 784.800 KN

Δv = 82.745 m/s

P = 48.704 MW

P = 65313.1399 Hp

3 RESULTS AND DISCUSSIONS

Based on the above calculation the final design parameters of the aircraft is given in table 6. The design is made in the Solid works and then analysed in the Ansys Fluent for the pressure contours.

The figures fig 3(a), fig 3(b) and fig 3(c) are the aircraft draft with design dimensions. This is still an experimental aircraft and the design parameters are still subjected to changes.

Figure 3(a) shows the top view of the aircraft with dimensions and the inner fuselage for storage. Figure 3(b) is the rotor dimension of one wing while figure 3(c) is the cross-sectional view of the wing showing how rotor is housed inside the wing.

Table 6

<table>
<tr><td colspan="2">Crew</td><td>2</td></tr>
<tr><td colspan="2">Length</td><td>50 m</td></tr>
<tr><td colspan="2">Height</td><td>5 m</td></tr>
<tr><td colspan="2">Wing area</td><td>5600m^2</td></tr>
<tr><td colspan="2">Wing span</td><td>140 m</td></tr>
<tr><td colspan="2">Mainbody chord</td><td>50 m</td></tr>
<tr><td colspan="2">Wing chord</td><td>32.5 m</td></tr>
<tr><td colspan="2">Aspect ratio</td><td>3.5</td></tr>
<tr><td colspan="2">Cruising speed</td><td>0.80Mach(at20,000m)</td></tr>
<tr><td colspan="2">Empty weight</td><td>50,000 kg</td></tr>
<tr><td colspan="2">Take-Off weight</td><td>120,000 kg</td></tr>
<tr><td colspan="2">Loaded Weight</td><td>100,000 kg</td></tr>
<tr><td colspan="2">Fuel Weight</td><td>55717 kg</td></tr>
<tr><td colspan="2">Thrust to Weight ratio</td><td>0.61</td></tr>
<tr><td colspan="2">Maximum Altitude</td><td>20,000 m</td></tr>
<tr><td colspan="2">Range</td><td>12,000 km</td></tr>
<tr><td colspan="2">Rate of climb</td><td>8.7 m/s</td></tr>
<tr><td colspan="2">Hovering Thrust</td><td>1177200N</td></tr>
<tr><td colspan="2">Power Required by fans</td><td>97.408 MW</td></tr>
<tr><th>Phase</th><th>Lift(KN)</th><th>Drag (KN)</th></tr>
<tr><td>Cruise</td><td>1150.22</td><td>59.65</td></tr>
<tr><td>Takeoff</td><td>423.792</td><td>31.76</td></tr>
<tr><td>Landing</td><td>497.366</td><td>37.273</td></tr>
</table>

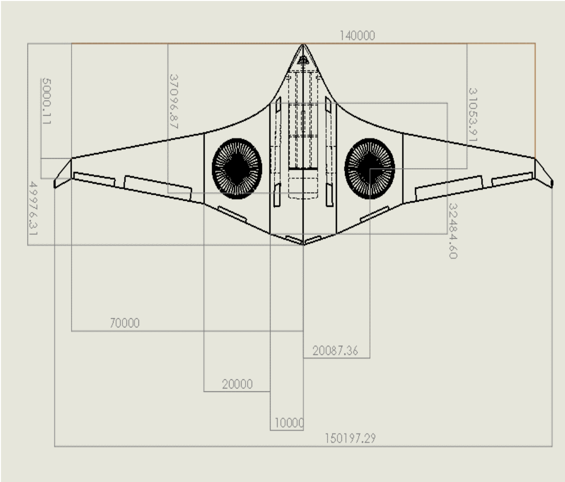

Figure 2(a)

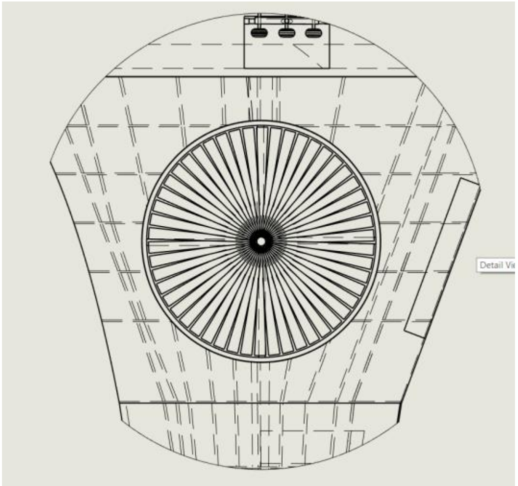

Figure 2(b)

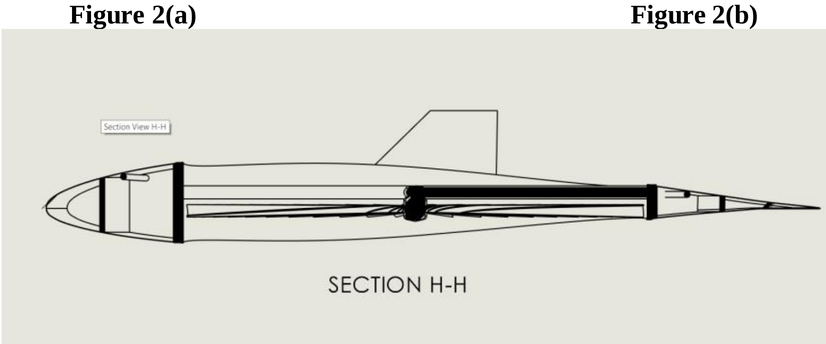

Figure 2(c)

The Figure 2(a) and Figure 2(b) are the Drafts of the Aircraft with Dimensions of Top view and the Fan view with Cross Sectional view of Wing is shown in Figure 2(c)

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3.1 AIRCRAFT DESIGN

The design of the aircraft made in solidworks is the real scale model. The figure 3.1 is the side view of the aircraft, figure 3.2 being the front view. Figure 3.3 is the top view and the rotor blades on the wing can be easily seen in this view and the figure 3.4 is the isometric view of the aircraft. Table 7 is the dimensions of the aircraft.

Table 7

Main body airfoil chord ©	50m
Root wing airfoil chord	32.5m
Mid wing airfoil chord	17.5m
Tip wing airfoil chord	5m
Root wing distance from main body mid plane	10m
Mid wing distance from main body mid plane	30m
Tip wing distance from main body mid plane	70m
Distance of fan rotor from main body Longitudinal axis	20.09m
Blade length	6.684m
Fan diameter	14.847m
Outer tilt Casing diameter	14.233m
Inner tilt casing diameter	13.933m
Thickness of the tilt casing	0.3m
Distance of fan centre from nose	31.05m
Number of blades in fan	50(each fan)

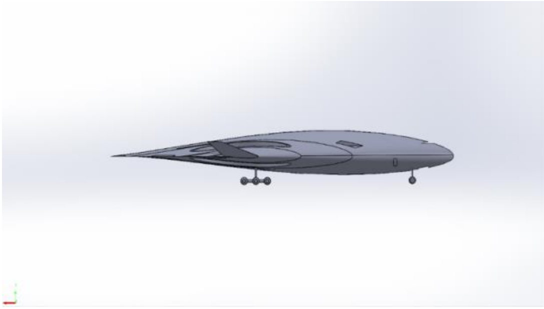

Figure 3.1

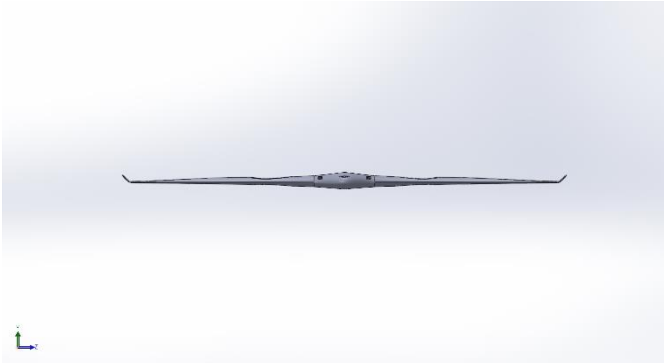

Figure 3.2

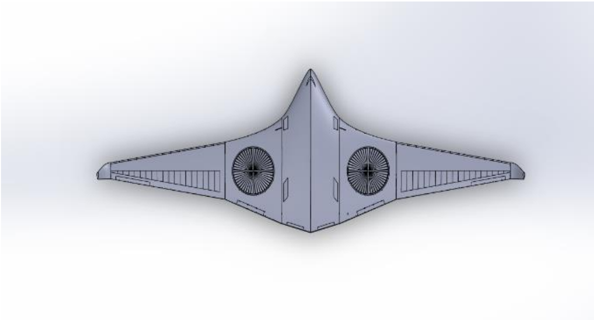

Figure 3.3

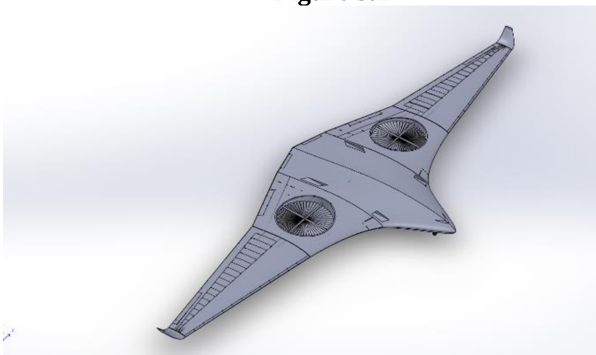

Figure 3.4

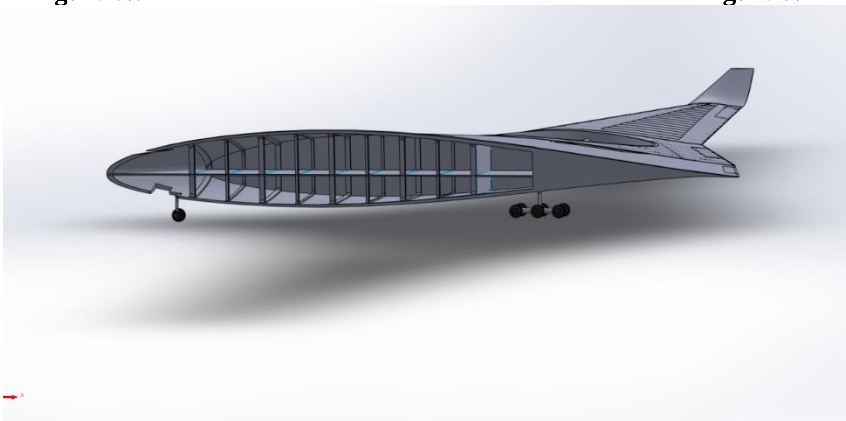

Figure 3.5

Figure 3.5 shows the cross-sectional view of the fuselage with the inner compartments being visible for crew, bomb storage and cargo.

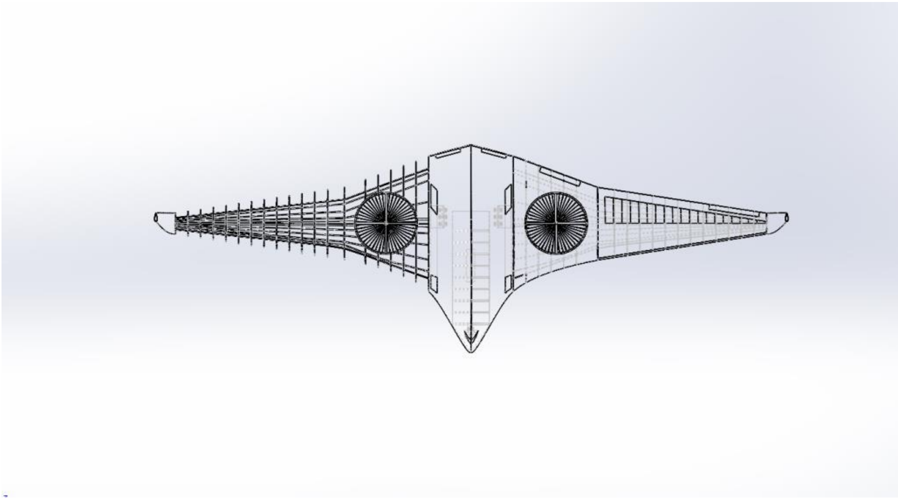

Figure 3.6

The fuselage currently has 5 bulkheads each of 400 mm and 4 frames each of 200 mm thickness. The fuselage is entirely made in the shape of different trapezoids arranged in a way to capture the airfoil curvature with having curved edges to avoid point loads concentration at those edges during loading.

Figure 3.6 is the assembly top view of the aircraft in SOLIDOWORKS with the wing internal structure visible. While figure 3.7 shows the wing structure of the aircraft. There are a total of 20 ribs each of 100 mm thickness with a rotor housing near the wing root and a spar and stringers to further support the wing structure and rotor housing.

3.2 Aircraft Analysis

The aircraft model is simulated in ANSYS Fluent to see the pressure distribution over the wing body. Figure 4(a) and 4(b) shows the pressure contour over the upper surface and lower surface of the aircraft body. The yellow lines are the flow direction which shows how the flow is moving around the aircraft body.

The figure 4(a) and 4(b) shows the meshing of the model in fluent. Table 8 shows the input values for the simulation.

Table 8

Flow velocity	236.08 m/s (for cruise at 0degree AOA) 18.5 m/s (for 10° AOA)
Air density	0.0889 kg/m^3 (for cruise) 1.225 kg/m^3 (for 10° AOA)
Air viscosity	1.422 *10^-5(for cruise) 1.789*10^-5 (for 10° AOA)
Operating Pressure	5529 Pascal (for cruise) 101325 Pascal (10° AOA
Model	Viscous (SST-K Omega)

Boundary Conditions

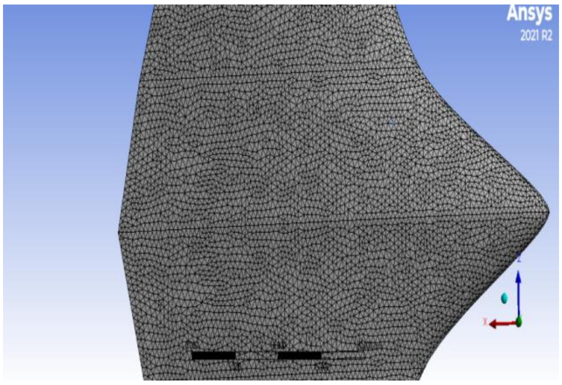

Figure 4(a): Elements Meshing over the Model

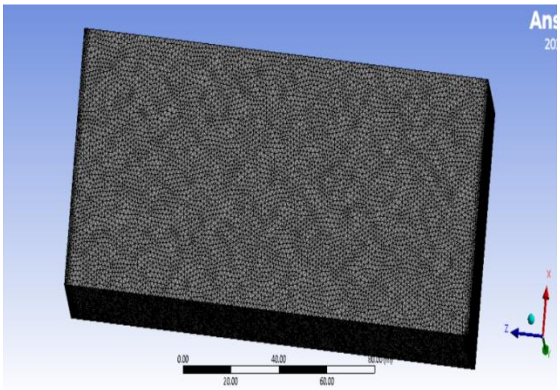

Figure 4(b) Elements Meshing over the Test Section

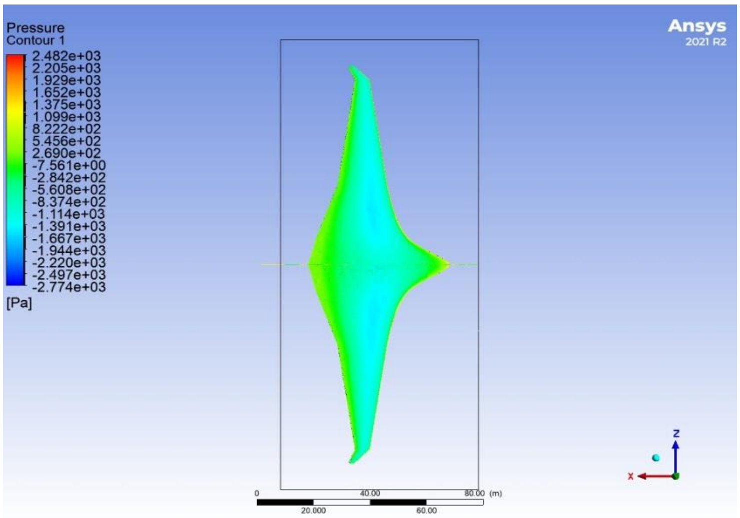

Figure 5 (a): Pressure Contour over upper Surface.

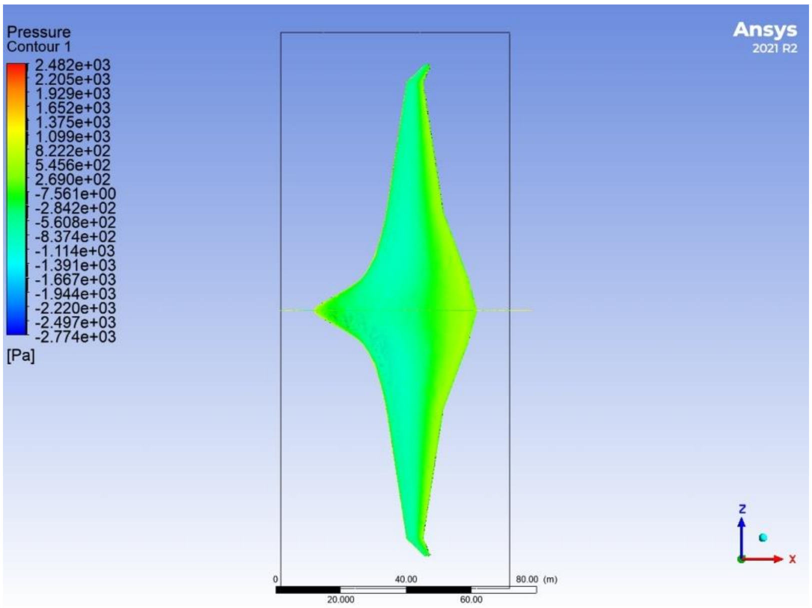

Figure 5 (b): Pressure Contour Over Lower Surface.

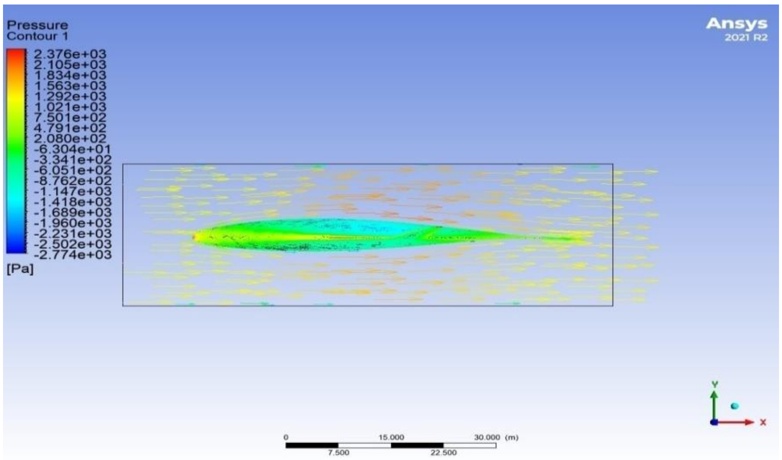

Figure 5(c): Force Vector over the Model.

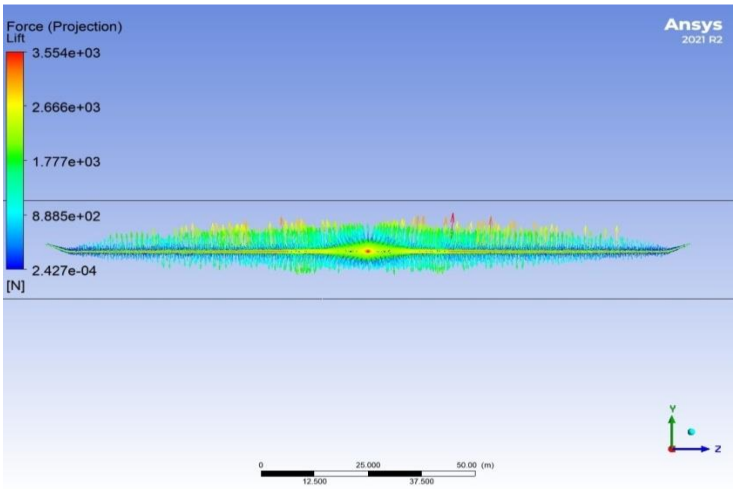

Figure 5(d): Velocity Vector with Pressure Contour over the Model.

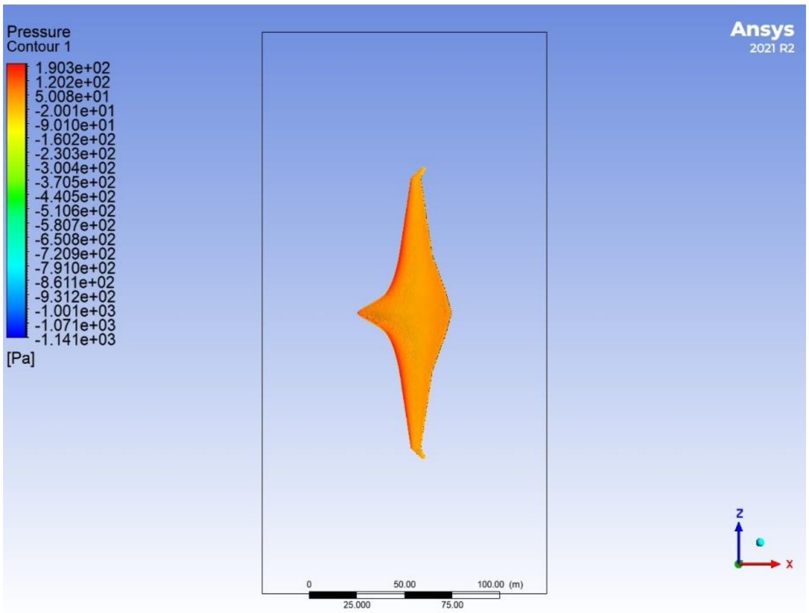

Figure 6(a): Pressure Contour over Upper Surface.

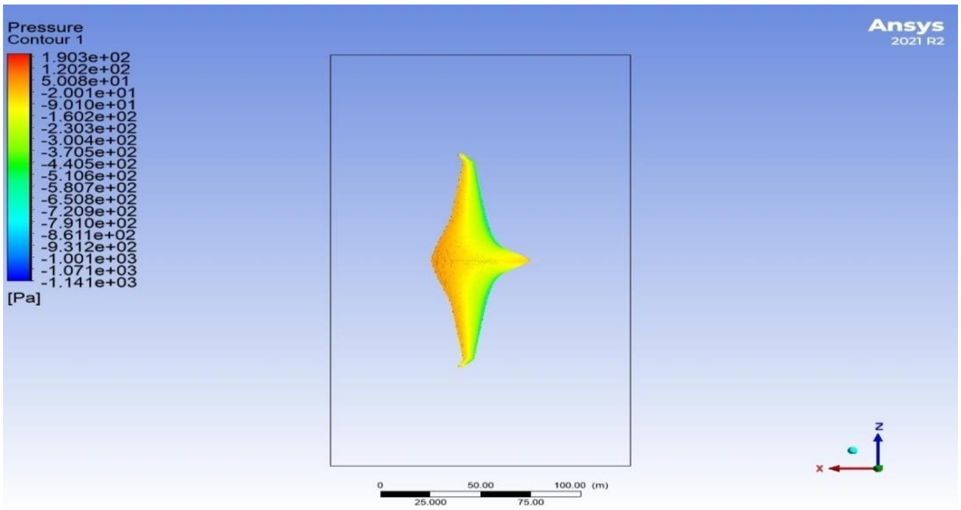

Figure 6(b): Pressure Contour over Lower Surface.

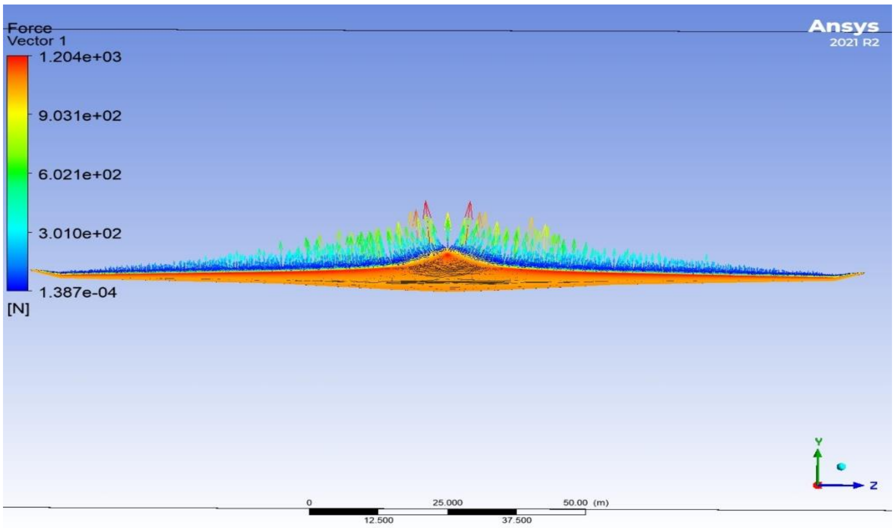

Figure 6(c): Front view of Force Vector over the Model.

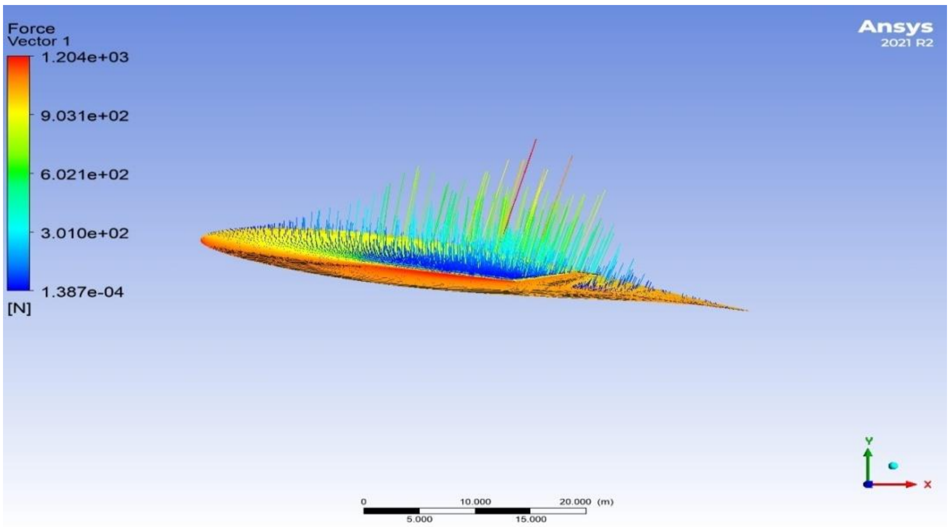

Figure 6(d): Side View of Force Vector over the Model.

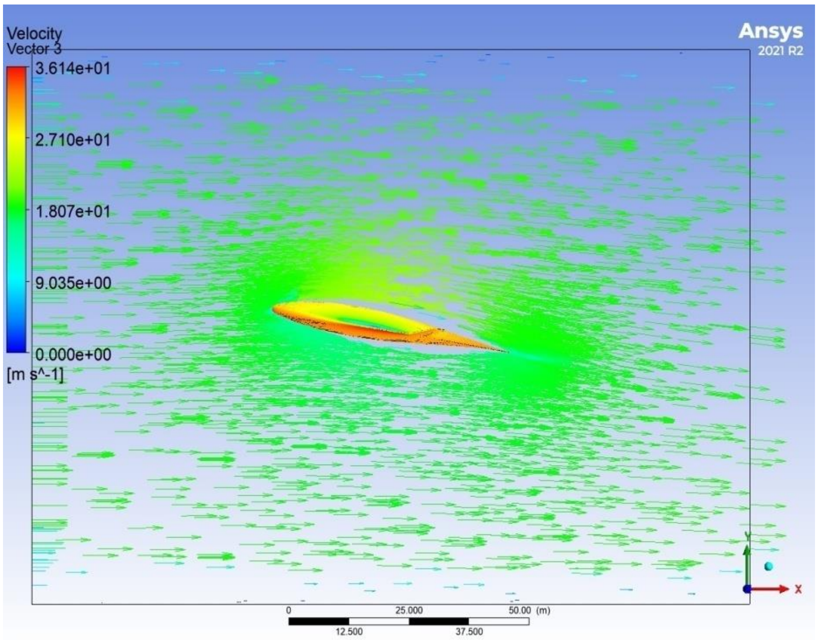

Figure 6(e): Velocity Vector over the Model with Pressure Contour.

The flow shows that there's a pressure difference over the upper and lower body which in terms will generate lift for the aircraft to fly. This also shows that some lift is also generated by the main fuselage of the aircraft cause of the blended wing design of the aircraft which will in turn increase the fuel efficiency of the aircraft by reducing the drag of the aircraft in compared to other aircrafts.

The figure 5(c) shows the Force vector over the model which is generally the aerodynamic forces produced on the model surface. The software calculated force of **1220.48 KN** over the Y-Axis which is the lift generation while **56.6364KN** at X-Axis which is drag at cruise condition was found out.

The figure 5(d) shows the velocity vectors of the air flowing around the model and how the air is changing its speed around the model with the Pressure contour which shows how the pressure over the aircraft model changes.

The figure 6(a) and 6(b) shows the aircraft at 10 degrees of AOA upper and lower surface pressure contours.

The figure 6(c) and 6(d) shows the force vector over the model at 10degree AOA from front and side view. The figure 6(e) shows the velocity vector or the flow around the aircraft model.

Table 9 is the comparison of the lift and drag simulated with theoretical calculation.

Table 9: Lift Comparison during Cruise between Simulated and Theoretical Calculation

Results	LIFT (KN) (0°)	LIFT (KN) (10°)	DRAG (KN) (0°)	DRAG (KN) (10°)
Simulated	1220.48	505.983	56.6364	44.89
Theoretical	1150.22	423.792	59.65	31.76

4 CONCLUSIONS

The preliminary design of a blended wing S/VTOL bomber/transport aircraft has been developed based on systematic calculations and appropriate references. The design may not fulfil the requirements of an actual aircraft, it is completely a

conceptual design. The design is always subjected to changes and implementation.

The simulation showed that the aircraft was producing sufficient lift at cruising condition for the aircraft to maintain flight and a good amount of lift which is approx. to the one calculated is generated at 10degree AOA with a flight velocity of 18.5 m/s which is basically the landing velocity at sea level. The aircraft is lacking a vertical tail for which the yawing motion is provided by the control surfaces n the winglet and varying the engine thrust with other control surfaces on the aircraft.

This aircraft can be changed to carry much more capacity of bombs in the future and would also be used as a rescue and transportation aircraft.

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